Two-Check & Priming Piston Pumps

Concept and Theory Training

GRACO

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Introduction

Welcome to ***Two-Check & Priming Pumps,*** a learning module in Graco's concept and theory sales training series. Your understanding of the information in this module provides the basis for further study on specific Graco products. Your ability to successfully promote and sell Graco products depends in part on how well you learn the basics and then apply this knowledge to addressing your customers' needs.

While this curriculum best fits the requirements of Graco and distributor sales people, it will also benefit anyone whose job function depends on knowledge of Graco's products.

Overview

Two-check and priming piston pumps represent a large percentage of Graco's sales. Therefore, you need to know these pumps well so you can effectively sell them and provide necessary service information to your customers. This module will help you to begin acquiring essential product knowledge. It provides basic information about standard two-check and priming piston pumps, including component identification and function, operating cycle, materials of construction, advantages and limitations, and typical uses for each type of pump.

How to Use this Module

The basic concept and theory curriculum consists of a series of self-study modules. As the term self-study implies, you work through the materials on your own at a comfortable pace. Plan sufficient time (approximately 30 minutes) to complete at least one section of a module in a working session.

This module combines a variety of features to make the learning process convenient and productive:

- Learning objectives
- Text
- Charts, illustrations
- Progress checks
- Additional resources

Learning Objectives

Each section of material offers a set of learning objectives. Read the objectives and use them to guide you to the most important concepts. After you finish each section and before you complete the progress check, reread the objectives to confirm that you understand the key concepts.

Text

Definitions, examples, and explanations comprise the learning module text. Read it carefully and return for review if necessary.

Charts, Illustrations

An imporant element of any instruction is visualizing the concepts. This module contains graphics and illustrations to enhance the text material and aid your learning. Where appropriate, the module also contains charts that help you organize or summarize information.

Progress Checks

Progress checks are self-tests that provide reinforcement and confirm your understanding of important topics. After completing each section of the module, return to review the objectives, and then work through each of the progress check items. Upon completion, check your answers against those provided. If you answered any incorrectly, return to the text and reread the pertinent information.

Additional Resources

This module may refer you to other documents or sources that expand on the concepts covered in the module. The reference will include the name of the source and how you can obtain it.

Form #303-706 ***Industrial Products Catalog***

Form #321-037 ***Moving Fluids***

Component Identification and Function

Learning Objectives

To effectively discuss two-check and priming piston pumps with your customers, you must be familiar with how these pumps operate. This section defines two-check and priming piston pumps, lists their trade names, identifies individual pump components, and describes component functions. Upon completion of the section, you should be able to:

- Define what is meant by a two-check piston pump.
- Identify and explain the function(s) of the basic components of a standard two-check piston pump.
- Define what is meant by a priming piston pump.
- Identify and explain the function(s) of the basic components of a priming piston pump.
- Name the types of feed methods that are used for loading priming piston pumps.

Two-Check Piston Pumps: Components

A two-check piston pump (shown in Figure 1) is a reciprocating displacement pump in which two check valves – the piston check valve and the intake check valve – control the flow of fluid through the fluid section.

Different types of check valve designs are used in two-check piston pumps, depending on the viscosity and other characteristics of the fluid to be pumped. The most common design is the ball check, so these pumps are often referred to as two-ball pumps. One trade name used for Graco's two-check pumps is Dura-Flo™.

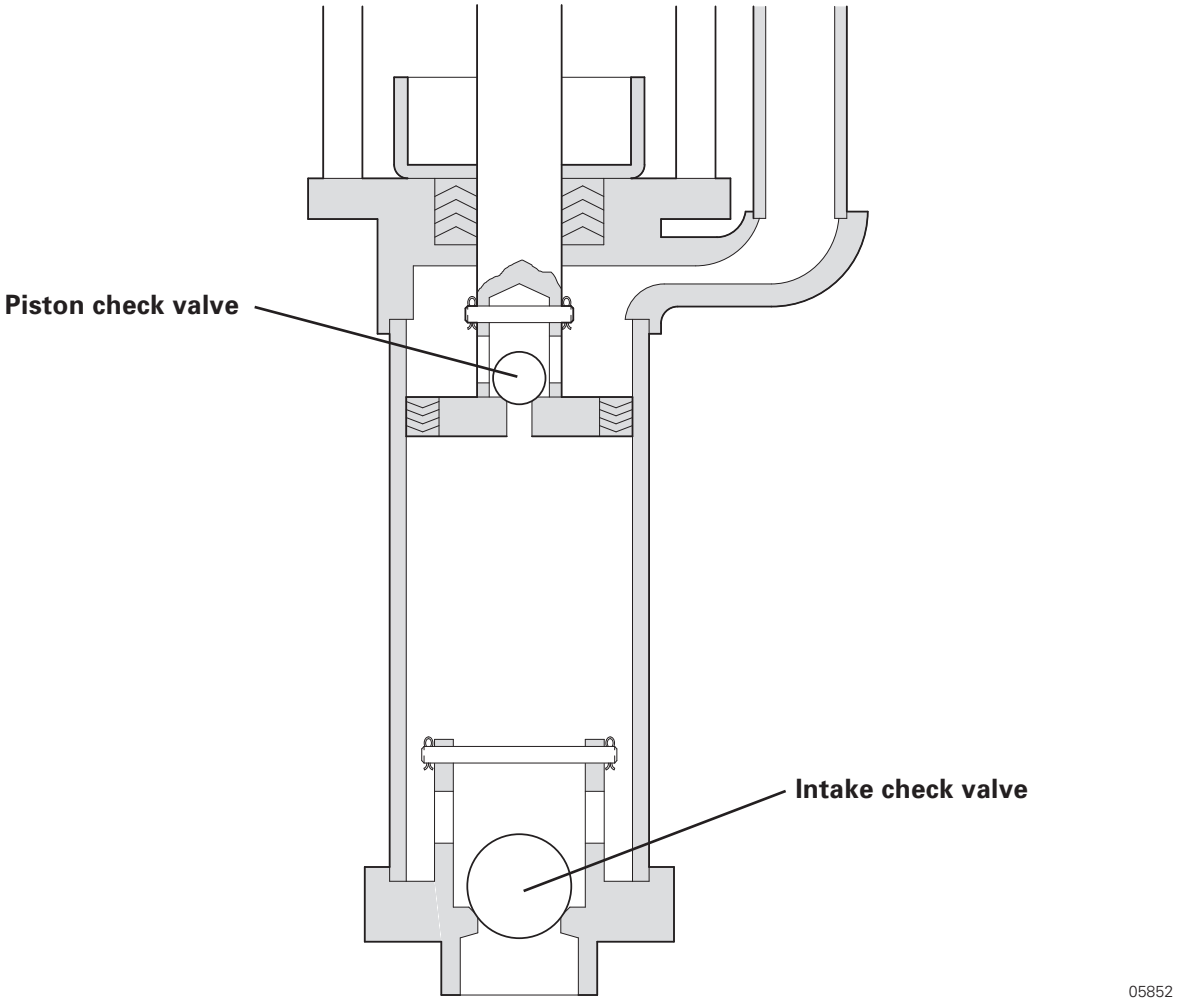


Figure 1 Two-check piston pump.

Standard two-check piston pumps contain the basic components shown in Figure 2.

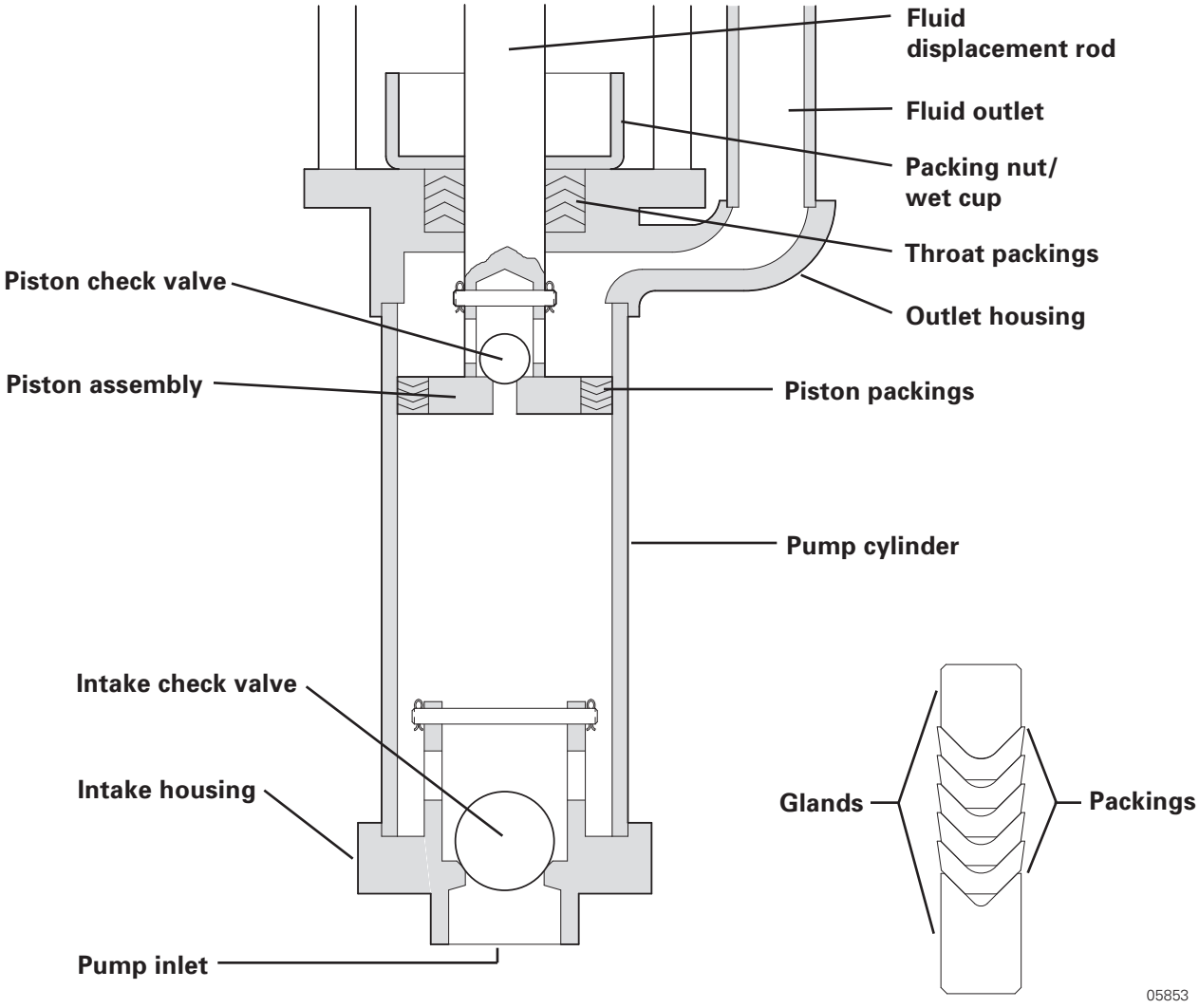


Figure 2 Components of a two-check piston pump.

These components function as follows:

The **fluid displacement rod,** or piston rod, connects the internal components of the pump to the motor. It moves up and down with the action of the motor, transferring the motor's power and motion to the pump piston. During both the upstroke and downstroke, it displaces fluid out of the pump.

The **throat packings** seal the fluid displacement rod to the outlet housing of the pump, preventing pressurized fluid from leaking out of the pump when the fluid displacement rod reciprocates. As the throat packings wear, there may be leakage into the wet cup. This leakage indicates that the packing nut must be tightened or that the throat packing seals and/or other fluid section components must be serviced.

The **packing nut/wet cup** has a dual function:

- The *packing nut* can be adjusted to apply pressure to the throat packings to help prevent fluid leaks past the fluid displacement rod. As the throat packings wear, the packing nut is tightened to stop packing leaks. It is only used with V-shaped packing seals and not with any other seal designs, such as U-cup.
- The *wet cup* is a reservoir that can be filled with either throat seal liquid (TSL) or iso pump oil (IPO) to extend the life of the throat packing seals.
    - TSL is used for coatings to minimize fluid buildup on the fluid displacement rod. TSL is not filled in sanitary applications; however, vegetable oil or an equivalent may be used.
    - ISO is used for moisture sensitive isocyanate to prevent crystals from forming on the fluid displacement rod. Reciprocation of a displacement rod that contain these crystals can cause premature wear of the throat packings.

The **outlet housing** is the pump structure that contains the fluid outlet and fitting, the throat packings, and packing nut/wet cup.

The **fluid outlet** is the opening where fluid exits from the pump. It contains a fitting. On some fluid sections, the diameter of this fitting may be tailored for the application.

The **pump cylinder** forms the outside wall of the pump cavity. It is where the fluid goes when the pump loads.

The **piston assembly** seals the fluid displacement rod to the inside wall of the pump cylinder. It consists of the piston check valve, ball housing, piston packings, and piston glands. In some pumps, a U-cup may be used in place of the glands and packings.

- The *ball housing* is attached to the end of the fluid displacement rod. It contains the piston check valve.
- The *piston packings* are the seals that seal the piston to the pump cylinder.
- The *piston glands* are metal pieces that are placed on each end of the packings to uniformly load them and help maintain their V shape. Figure 2A shows a closeup of piston packings and glands.

The **piston check valve,** which consists of the piston ball and piston seat, operates in conjunction with the fluid displacement rod inside the pump cylinder. It opens and closes, controlling the flow of material through the pump.

- When the fluid displacement rod moves up, the piston check valve closes and seals tightly on a seat. Fluid trapped above the piston check valve is forced out of the pump through the fluid outlet. A low pressure area is created below the piston check valve in the pump cylinder cavity. This low pressure area helps to open the intake check valve and draw fluid into the pump.
- When the fluid displacement rod moves down, the piston check valve opens. Its opening allows the fluid below the piston check valve to flow freely through the piston check to the fluid section above and out of the pump.

The **intake check valve,** or foot valve, also opens and closes with the action of the fluid displacement rod. Intake check valve designs may vary. Most pumps use ball-type checks, but some may use a flat plate instead of a ball. The components of the ball-type intake check valve are the intake ball and intake seat.

- When the fluid displacement rod moves up, the intake check valve opens, allowing fluid to enter into the pump cylinder.
- When the fluid displacement rod moves down, the intake check valve closes, preventing the loaded fluid in the pump cylinder from being forced back out the pump inlet.

The **intake housing** is the pump structure that contains the intake check valve.

The **pump inlet** is where the fluid enters the pump.

Some two-check pumps also have a bleed valve that is used to vent, or bleed, air that is trapped within the fluid section. The pump primes easier when there is no air inside the pump.

Progress Check

Directions: After answering the following questions, compare your answers with those proved in the answer key following this progress check. If you respond to any items incorrectly, return to the text and review the appropriate topics.

1. Which statement(s) describe(s) a two-check piston pump

   You may select one or more answers.

   a. It is a reciprocating displacement pump.

   b. It is the most common type of centrifugal pump.

   c. Entry and exit check valves control the flow of fluid through the fluid section.

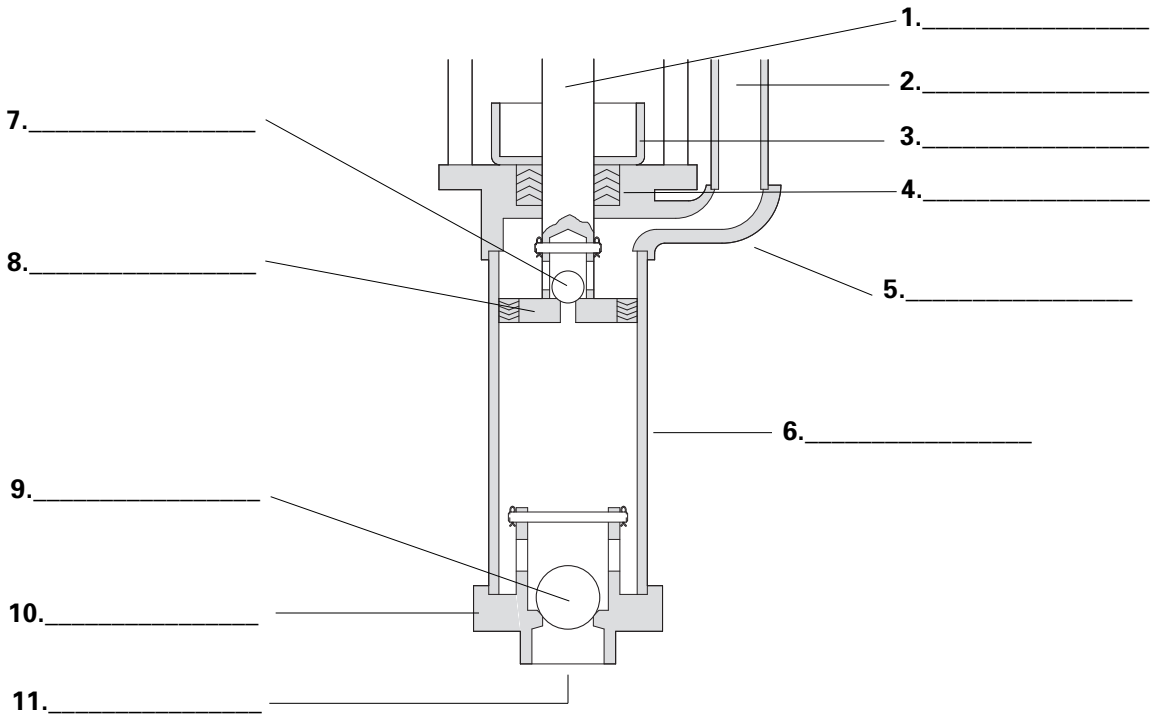
   d. Piston and intake check valves control the flow of fluid through the fluid section.

   e. Its most common check valve design is the chop and check.

   f. Its most common check valve design is the ball check.

2. *Write the name of the correct two-check piston pump component in the blank following each number. Choose from the list below.*

Fluid displacement rod	Packing nut/wet cup	Throat packings
Outlet housing	Pump inlet	Intake housing
Pump cylinder	Intake check valve	Piston check valve
Fluid outlet	Piston assembly	



3. *In each blank, write the name of the two-check piston pump component(s) that match(es) the described function. Choose from the list in the previous question.*

   a. _____ Contains the fluid outlet and fitting, the throat packings, and packing nut/wet cup.

   b. _____ Seals the fluid displacement rod to the inside wall of the pump cylinder.

   c._____ Open and close with the action of the fluid displacement rod, controlling the flow of material through the pumpd.

   d. _____ Contains the intake check valvee.

   e._____ Where the fluid enters the pump

   f._____ Where the fluid goes when the pump primes

   g. _____ Connects the internal components of the pump to the drive source

   h. _____ Where the fluid exits from the pump

   i._____ Seal the fluid displacement rod to the outlet housing

   j._____ Can be adjusted to apply pressure to the throat packings to prevent leaks

past the fluid displacement rod

Answers to Progress Check

1. A, d, and f are correct. A two-check piston pump is a reciprocating displacement pump in which two check valves – the piston check valve and the intake check valve – control the flow of material through the fluid section. The most common type of check valve design used in a two-check piston pump is the ball check

2. The correct answers are:

   [1] Fluid displacement rod

   [2] Fluid outlet

   [3] Packing nut/wet cup

   [4] Throat packings

   [5] Outlet housing

   [6] Pump cylinder

   [7] Piston check valve

   [8] Piston assembly

   [9] Intake check valve

   [10] Intake housing

   [11] Pump inlet

3. The correct answers are:

   a. The outlet housing contains the fluid outlet and fitting, the throat packings, and packing nut/wet cup.

   b. The piston assembly seals the fluid displacement rod to the inside wall of the pump cylinder.

   c. The piston and intake check valves open and close with the action of the fluid displacement rod, controlling the flow of material through the pump.

   d. The intake housing contains the intake check valve.

   e. The pump inlet is where the fluid enters the pump.

   f. The pump cylinder is where the fluid goes when the pump primes.

   g. The fluid displacement rod connects the internal components of the pump to the drive source.

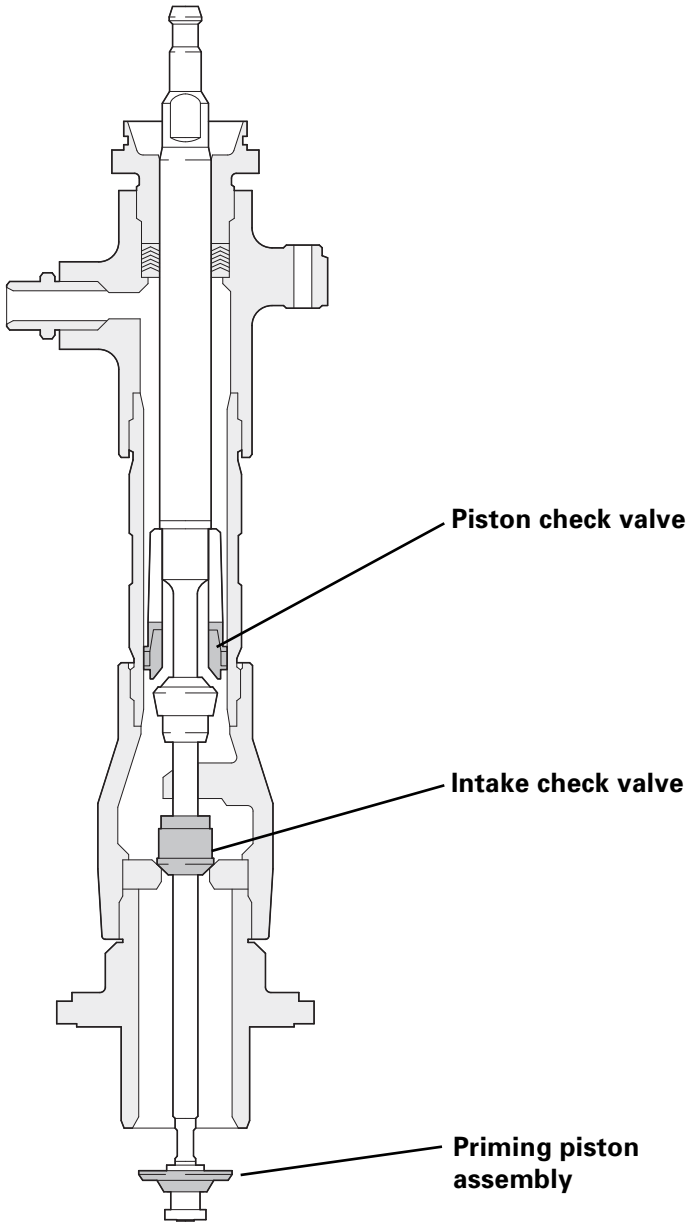
   h. The fluid outlet is where the fluid exits from the pump.

   i. The throat packings seal the fluid displacement rod to the outlet housing.

j. The packing nut can be adjusted to apply pressure to the throat packings to prevent leaks past the fluid displacement rod.

Priming Piston Pumps: Components

Priming piston pumps are reciprocating, two-check displacement pumps that include a priming piston assembly, or shovel, at the bottom. They are designed to pump highly viscous, non-flowable, fiber- or



chunk-filled materials and greases more efficiently than standard two-check piston pumps. One trade name for the priming piston pump series that Graco manufactures is Check-mate™.

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Figure 3 shows an example of a priming piston pump.

Figure 3 Priming piston pump.

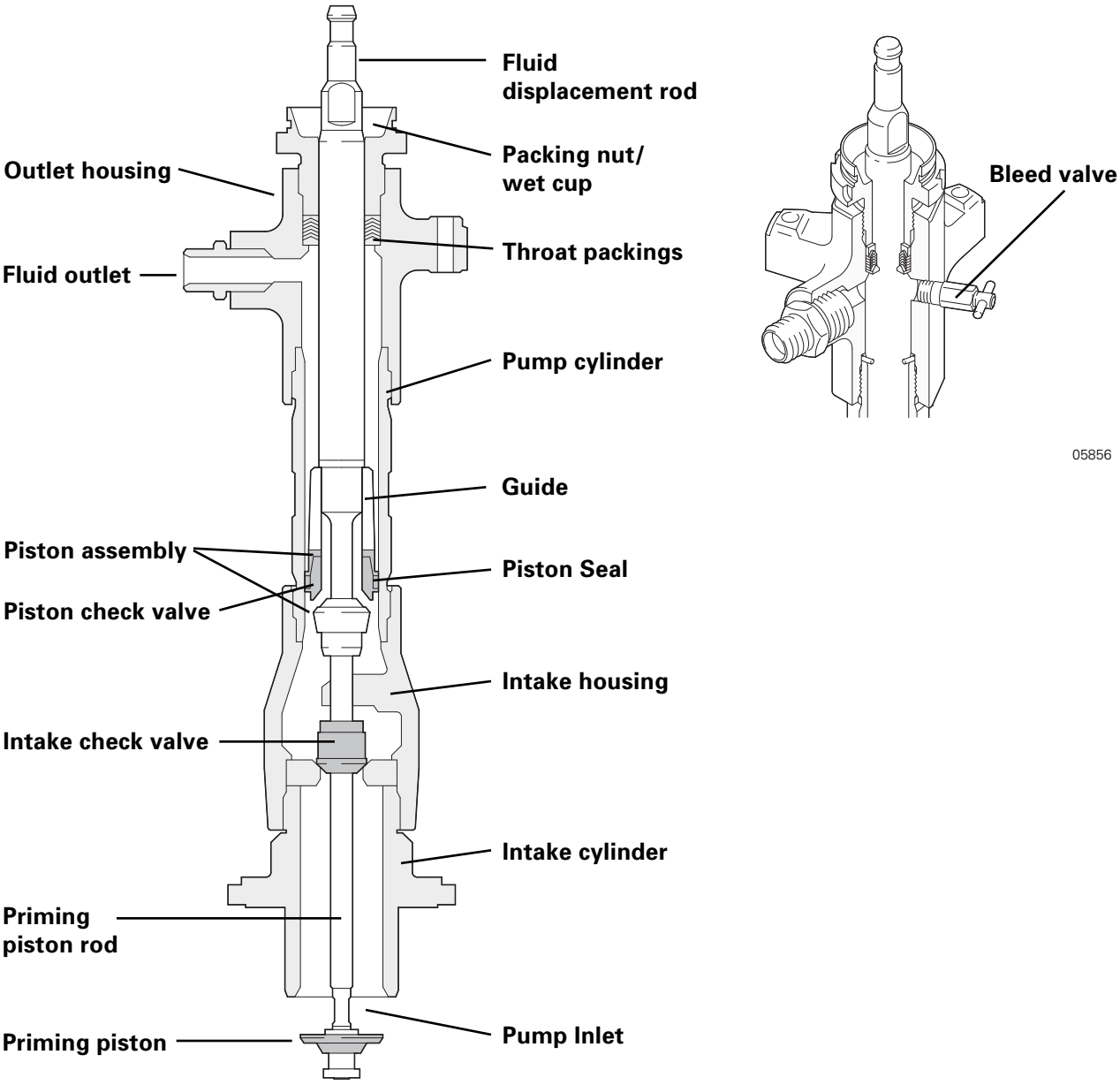


Figure 4 shows the components of a priming piston pump. As you can see, priming piston pumps contain the same basic components that standard two-check piston pumps do. Those components

function in essentially the same way.

Figure 4 Components of a priming piston pump.

Differences between the two pump designs are:

- All priming piston pumps are equipped with bleed valves to aid in priming. Standard two-check piston pumps may or may not have them. A bleed valve is shown close up in Figure 4A.
- The piston assembly in a priming piston pump consists of the piston check, seat, guide, and piston seal (the equivalent of packings and glands). Its function is the same - to seal the displacement rod to the inside wall of the cylinder.
- The intake check valve in a priming piston pump is designed with a priming piston rod running through it that connects the priming piston to the fluid displacement rod.

Priming piston pumps contain these additional components, which function as follows:

- The **priming piston** loads fluid through the intake cylinder, past the intake check valve, and into the pump cyclinder during the upstroke. Various designs are used based on the type of fluid being pumped.
- The **priming piston rod** is the shaft that connects the priming piston to the bottom of the fluid displacement rod.

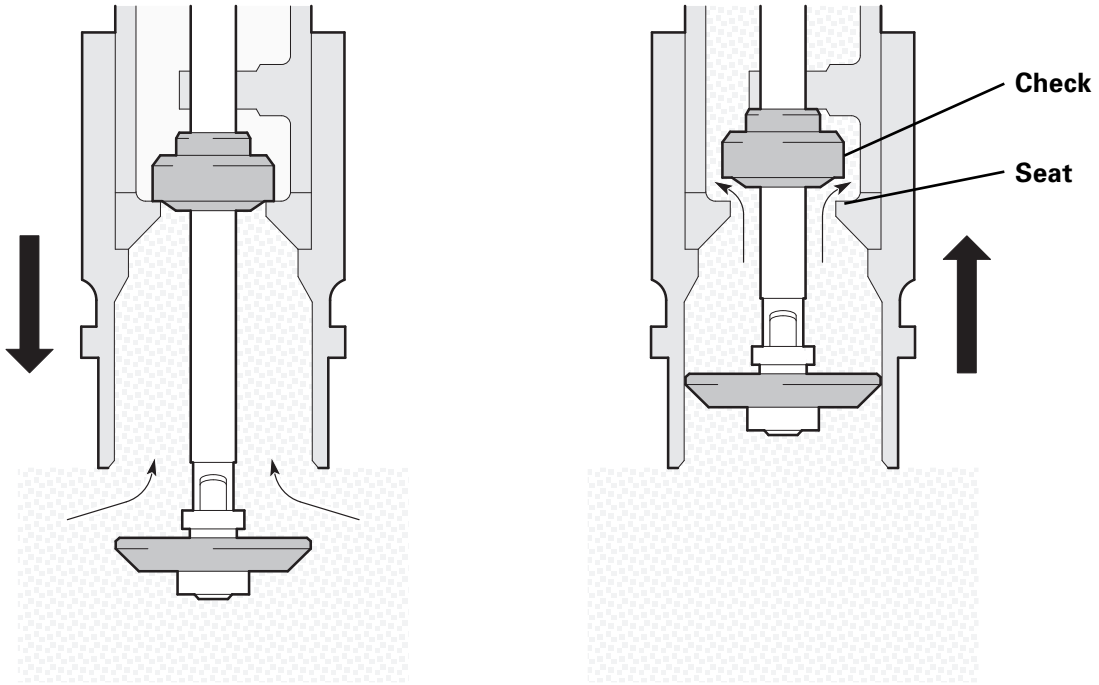
  The **intake cylinder** contains the priming piston assembly (the priming piston and priming piston rod). It provides the mounting surface for floor stands, drums, and inductor plates.

In priming piston pumps, intake and piston check valve designs vary significantly based on the type of fluid being pumped. “Chop and check” valve designs are typically used to maintain pumping efficiency in extremely viscous fluids or fluids with stringy or fibrous fillers. “Chop and check” designs may be used both on the intake and piston check valves. To ensure a positive seal, the “chop and check”

valve first chops through the material. This allows the valve to seat or "check" well enough to efficiently control fluid flow. In addition, "chop and check" designs have large internal porting that allows viscous materials to move through without large pressure losses when the valve is open.

This design for the intake check valve (shown in Figure 5) includes a valve that is mounted on the priming piston rod and a stationary seat that is part of the intake housing. The check valve components are designed so that the seating surfaces are always properly aligned.

During downstroke, as the valve is driven down by friction with the priming piston rod seal, it chops through the material, then seals against the seat. Fluid pressure above tbe check valve helps seat the valve, ensuring a complete "chop and check." Fifty percent of the fluid trapped above the intake check valve is displaced from the pump by the descending displacement rod.

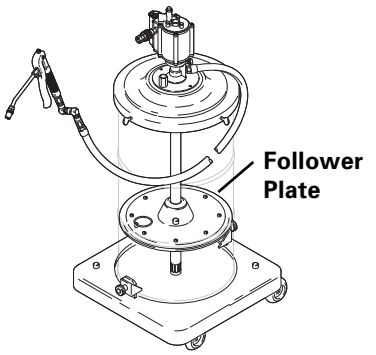


During upstroke, the valve is lifted off the seat by friction with the priming piston rod seal. Fluid is

pushed past the open check valve by the priming piston.

Figure 5 Chop and check intake valve.

Chop and check intake check valveLike all reciprocating piston pumps, priming piston pumps require a positive fluid pressure in order to load. Because these pumps are used with highly viscous materials, they require the use of more complex feed methods than some other types of pumps. The positive fluid pressure required for loading by priming piston pumps is created by follower plates, inductor, or ram feed methods, all of which are described briefly in Figure 6. For more information about pump loading, refer to the module ***Moving Fluids.***



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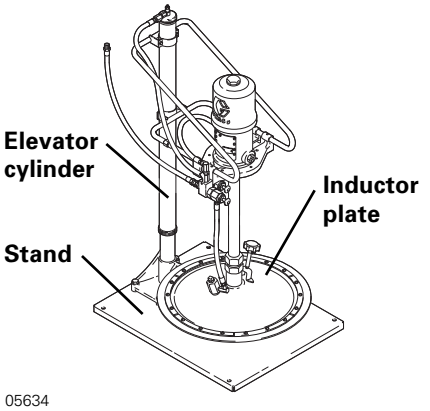
Follower Plates - Immersion Feed

Heavy follower plates float on the surface of the fluid to be pumped. Their weight exerts a positive pressure on the fluid that helps to prime the pump.

Figure 6a Follower Plates - Immersion Feed.



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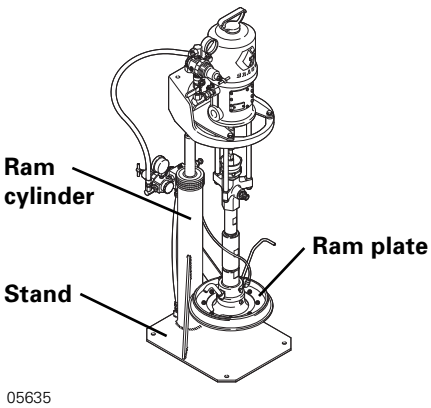
Inductor System - Pressure Feed

An inductor system consists of a pump, motor, inductor plate, elevator ram, and stand. Atmospheric pressure on the inductor plate plus the weight of the plate and pump exert a positive pressure on the fluid that helps to prime the pump.

Figure 6b Inductor System - Pressure Feed.



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Ram System - Pressure Feed

A ram system consists of a pump, motor, ram plate, ram cylinder(s), and stand. Atmospheric pressure on the ram plate, the weight of the plate and pump, and the down force from one or more ram cylinders exert a positive pressure on the fluid that helps to prime the pump. Heated ram

plates, or platens, may also be used to reduce the viscosity of certain fluids so that they can be pumped.

Figure 6c Ram System - Pressure Feed.

Figure 6 Feeding methods used for priming piston pumps.

Progress Check

Directions: After answering the following questions, compare your answers with those proved in the answer key following this progress check. If you respond to any items incorrectly, return to the text and review the appropriate topics.

1. *Fill in the blank to make the statement about priming piston pumps true.*

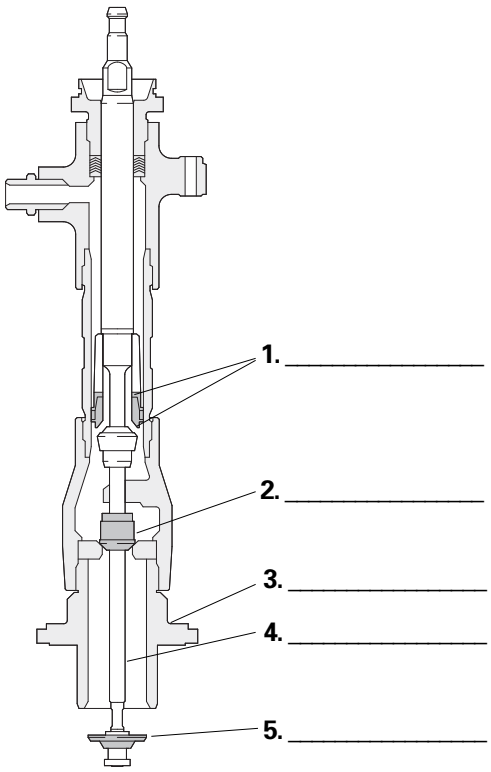
   Priming piston pumps are reciprocating, two-check displacement pumps with a _____ at the bottom.

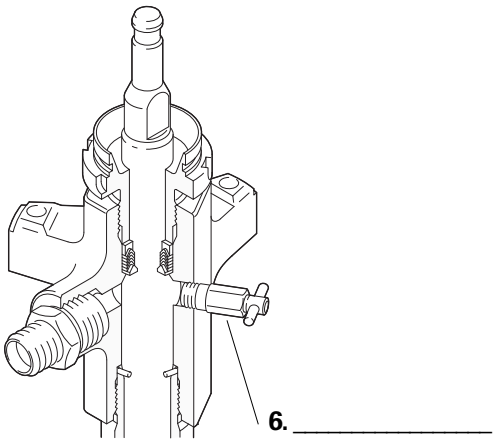
2. *True or False:* Priming piston pumps are designed to pump high-viscosity materials more efficiently than standard two-check piston pumps.

   True

   False

3. *Write the name of the correct priming piston pump component in the blank following each number. Choose from the list below.*





Bleed valve	Intake cylinder	Priming piston
Intake check valve	Piston assembly	Priming piston rod

Hint: Each component marked here represents a difference from the standard two-check piston pump.

In each blank, write the name of the priming piston component that matches the described function. Choose from the list in the previous question.

a. _____ Seals the fluid displacement rod to the inside wall of the pump cyclinder.

b. _____ Loads material into the pump cylinder during the upstroke phase of pump operation.

c. _____ Contains the priming piston assembly

d. _____ Open and close with the action of the fluid displacement rod, controlling the flow of fluid through the pump.

e. _____ Vents air trapped within the fluid section.

f. _____ Connects the priming piston to the fluid displacement rod.

5. For priming piston pumps to load, the required positive fluid pressure must be created by these

feeding methods:

a. _____

b. _____

c. _____

Answers to Progress Check

1. Priming piston pumps are reciprocating, two-check displacement pumps with a priming piston assembly at the bottom.

2. True. Priming piston pumps are designed to pump high-viscosity, non-flowable, fiber- or chunk-filled materials more efficiently than standard two-check piston pumps.

3. The correct answers are:

   [1] Piston assembly

   [2] Intake check valve

   [3] Intake cylinder

   [4] Priming piston rod

   [5] Priming piston

   [6] Bleed valve

4. The correct answers are:

   a. The piston assembly seals the fluid displacement rod to the inside wall of the pump cyclinder.

   b. The priming piston loads material into the pump cylinder during the upstroke phase of pump operation.

   c. The intake cylinder contains the priming piston assembly.

   d. The piston and intake check valves open and close with the action of the fluid displacement rod, controlling the flow of fluid through the pump.

   e. The bleed valve vents air trapped within the fluid section.

f. The priming piston rod connects the priming piston to the fluid displacement rod.

5. The correct answers are, in any order:

   a. Follower plates

   b. Inductor systems

   c. Ram systems

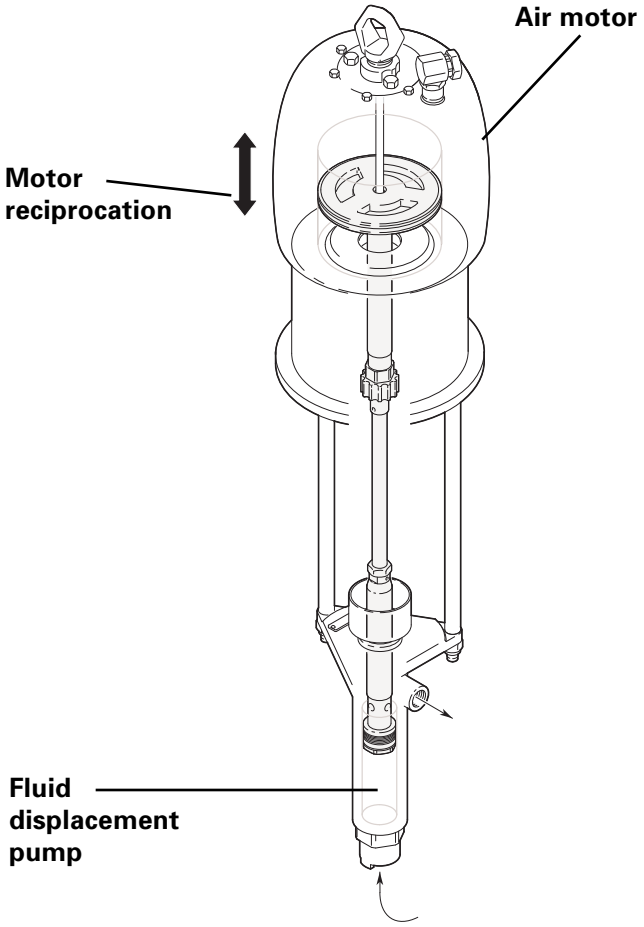
How Two-Check & Priming Piston Pumps Work

Learning Objectives

Knowing how two-check and priming piston pumps work will allow you to answer customer questions and to correctly identify sales opportunities. This section first describes briefly the various motors for standard two-check and priming piston pumps. Then it discusses how pump components function during the upstroke and downstroke phases of each pump's operating cycle and what happens during

each phase to the material being pumped. Upon completion of the section, you should be able to:

- Identify various ways that two-check and priming piston pumps can be driven.



Air Motor driven pump

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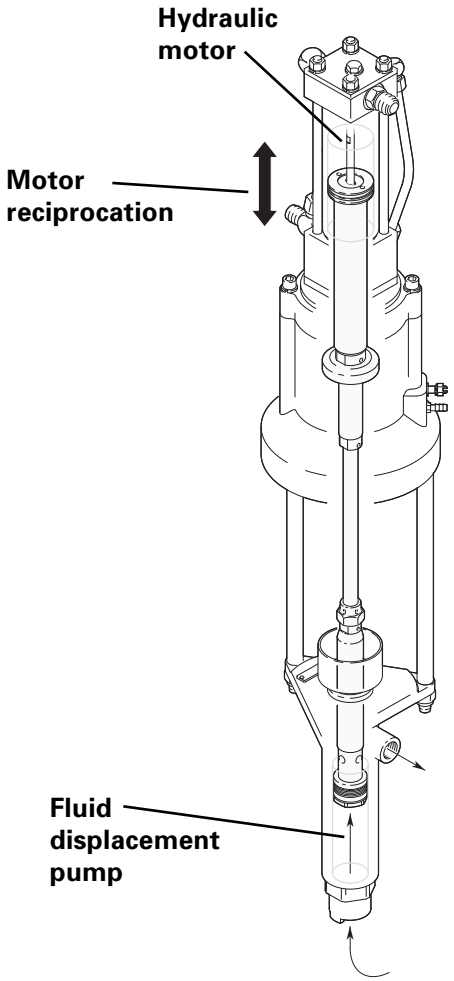

Hydraulic Motor driven pump

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- Describe what occurs during the upstroke and downstroke phases of the two-check piston pump's operating cycle.
- Describe what occurs during the upstroke, downstroke, and changeover phases of the priming piston pump's operating cycle.

Motors

Two-check and priming piston pumps are most commonly powered by air motors and hydraulic motors.

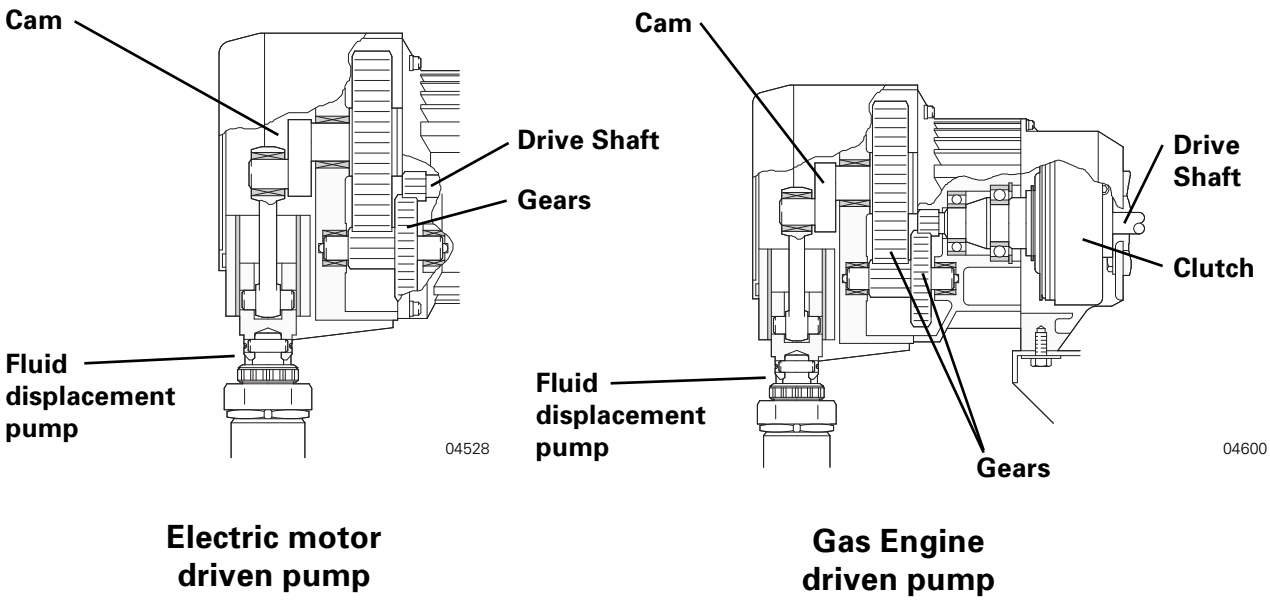


Figure 7 Air and hydraulic motor-driven pumps.

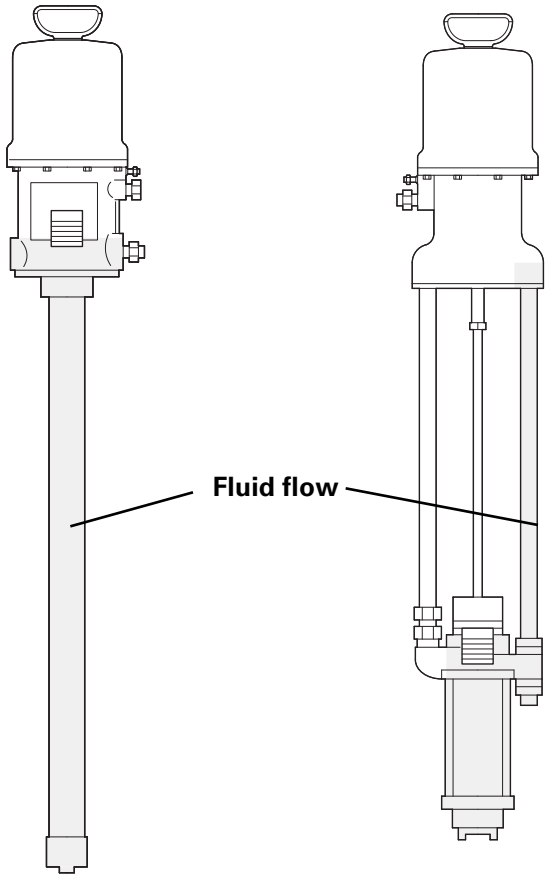
As shown in Figure 7, when an air motor is powered by compressed air or a hydraulic motor is powered by pressurized hydraulic oil, the flow of the air or the hydraulic oil through the motor causes the motor piston and rod to move up and down. This reciprocating motion is then transferred from the

motor rod to the fluid displacement rod in the pump.

Two-check and priming piston pumps may also be driven by electric motors or gas engines (shown in Figure 8).

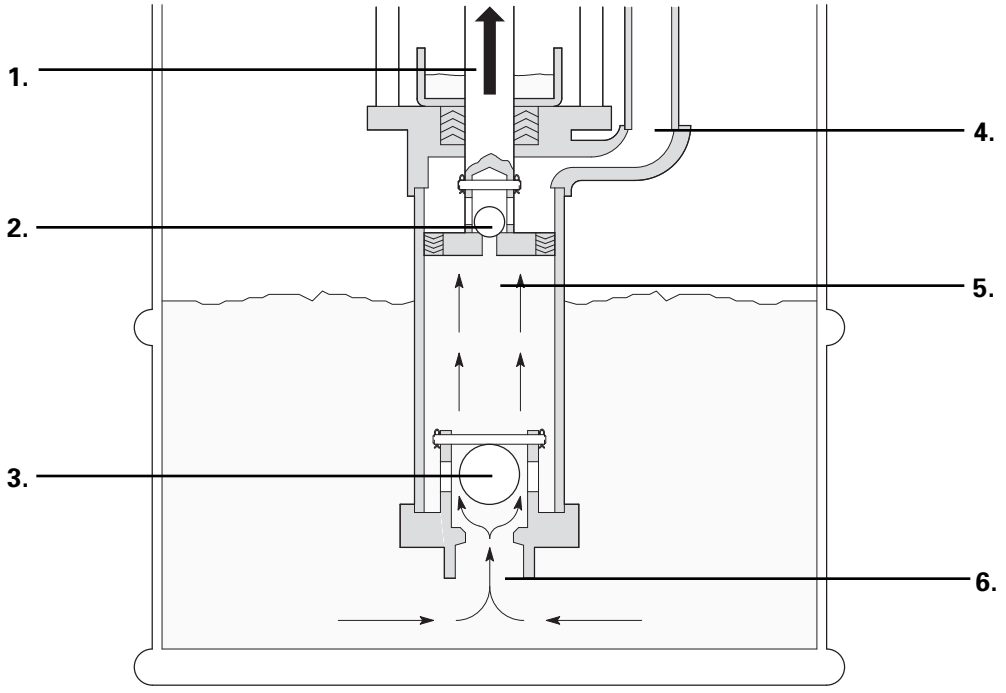
Figure 8 Electric motor- and gas engine-powered pumps.

In electric motors and gas engines, the motor or engine creates a rotating motion that is transferred to the drive shaft. The gears and cam in electric motors or the clutch and gears in gas engines then convert the rotating motion of the drive shaft into the reciprocating action of fluid displacement rod in the pump.



Drive sources may be attached to two-check and priming piston pumps and other types of fluid sections or pump lowers in the two basic ways shown in Figure 9.

In the in-line design, the motor rod is connected to the fluid displacement rod in the pump and the pump body is attached directly to the motor base. This design is used exclusively for lubrication pumps. Leakage of the pumped fluid, an oil or grease, from the throat packings into the motor is



not a problem, but a benefit.

The divorced design, in which the motor and pump are attached by a connecting rod and held together by tie rods, is used in all other types of pumps to prevent fluid leaks from the throat packings in the pump from contaminating the motor.

Figure 9 In-line and divorced pump designs.

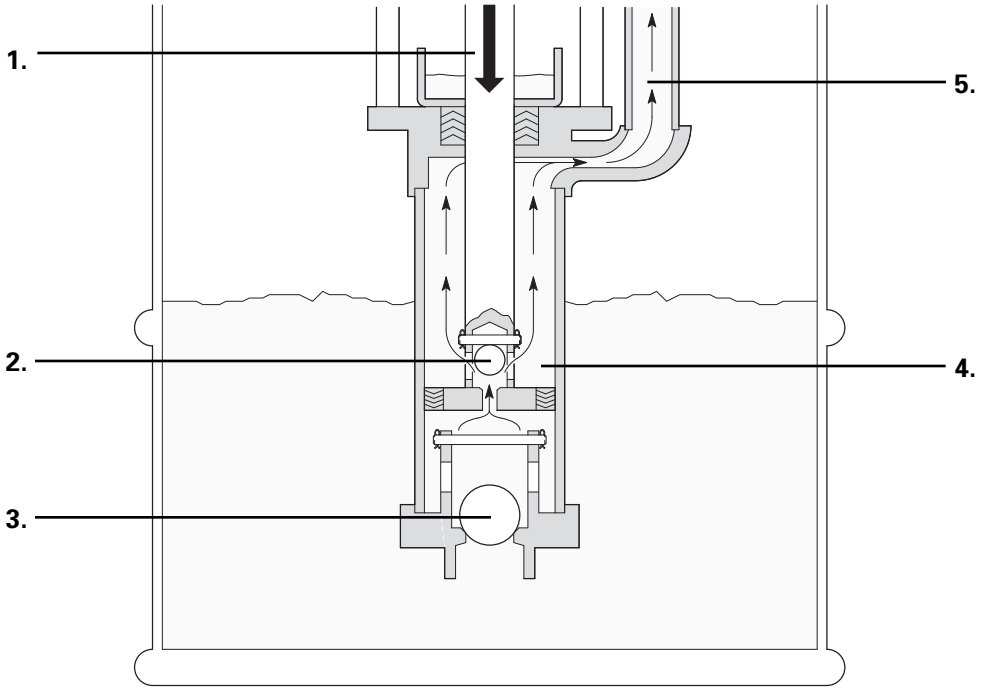
Two-Check Piston Pumps: Operating Cycle

The two-check piston pump's operating cycle consists of upstroke and downstroke phases. During upstroke, the two-check piston pump components work as shown in Figure 10:

Figure 10 Upstroke, two-check piston pump.

1. The motor pulls the fluid displacement rod up.

2. The piston check valve closes.



3. The intake check valve opens.
4. Any fluid above the piston check valve in the pump cylinder is trapped there. As the fluid

displacement rod moves up, it forces half of the trapped fluid out of the pump through the fluid outlet. This occurs since the volume of the rod is half the volume of the pump cylinder.

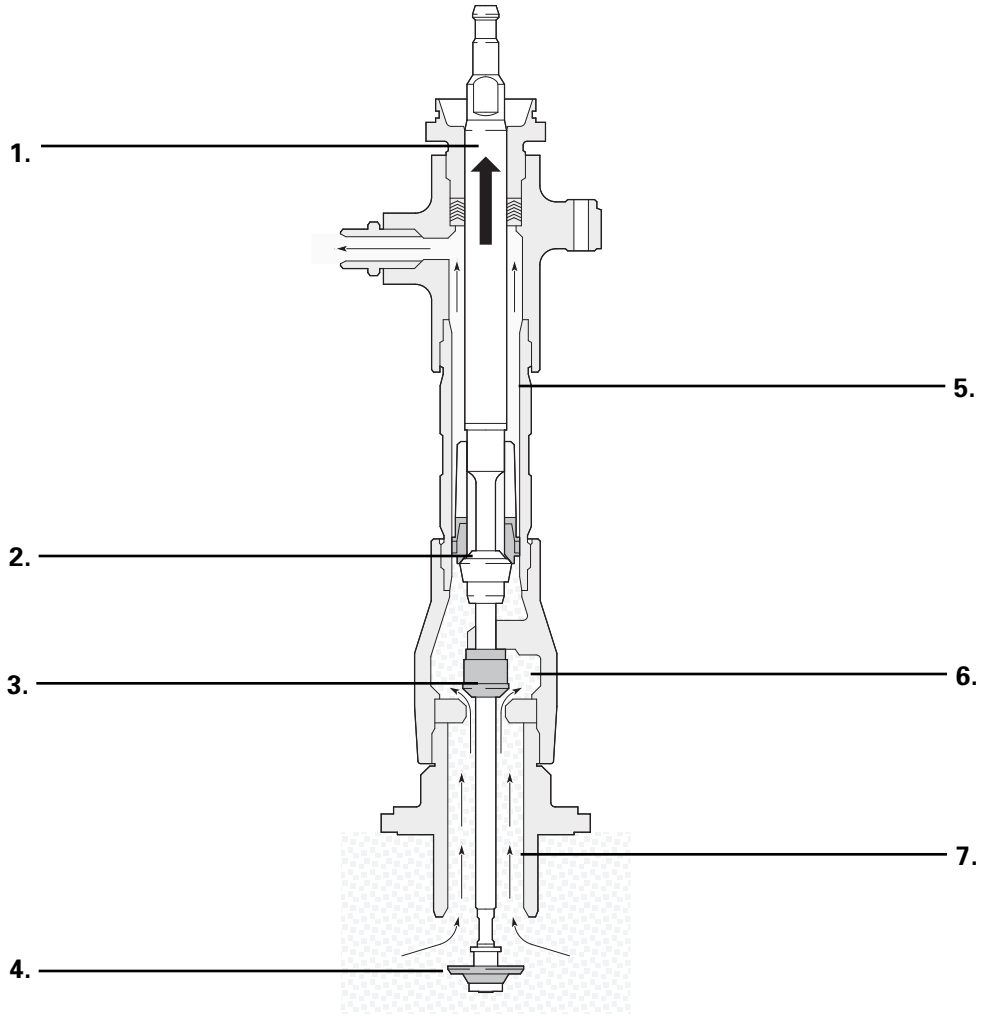
5. A low-pressure area is created inside the pump cylinder below the piston assembly.
6. Atmospheric pressure pushes fluid from the supply container past the open intake check valve into the pump cylinder. Fluid fills 100 percent of the volume of the pump cylinder.

During downstroke, two-check piston pump components work as shown in Figure 11:

Figure 11 Downstroke, two-check piston pump.

1. The motor pushes the fluid displacement rod down.

2. The piston check valve opens.
3. The intake check valve closes.
4. The fluid that was loaded into the pump cylinder during the upstroke is trapped inside the pump



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cylinder. It flows through the piston check valve.

5. Because the fluid displacement rod is half the volume of the pump cylinder, half the fluid

transferred through the piston check valve in the pump cylinder is forced out of the pump through the fluid outlet. The other half of the fluid transferred through the piston check valve will be displaced out of the pump with the next upstroke.

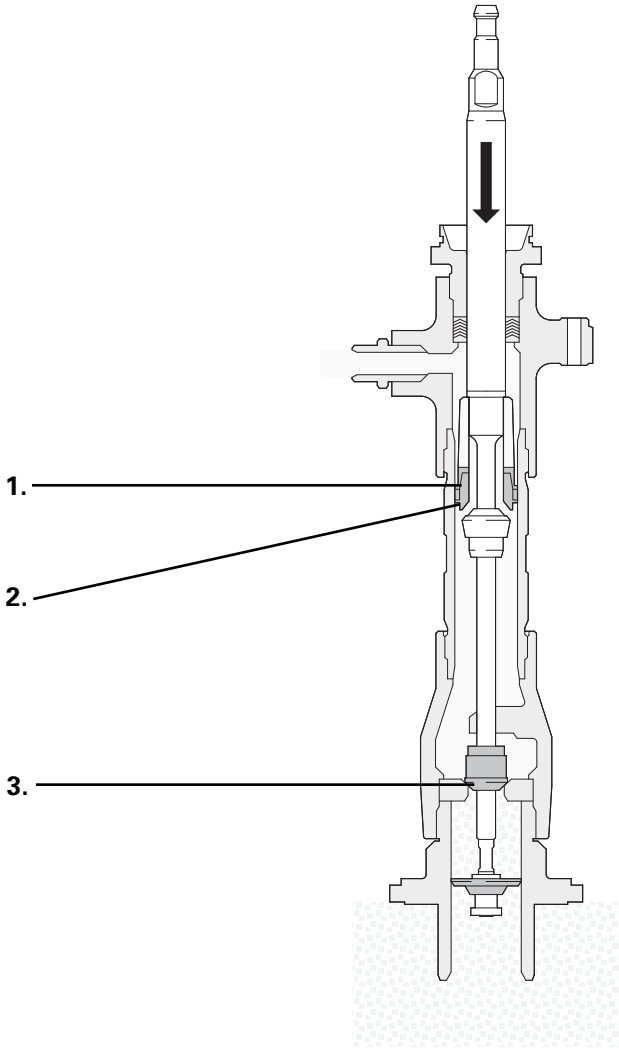
Priming Piston Pumps: Operating Cycle

The priming piston pump's operating cycle is similar to that of the standard two-check piston pump. It consists of these phases - the upstroke, top changeover, downstroke, and bottom changeover. During upstroke, the pump components work as shown in Figure 12.

Figure 12 Upstroke, priming piston pump.

1. The motor pulls the fluid displacement rod up.

2. The piston check valve closes.



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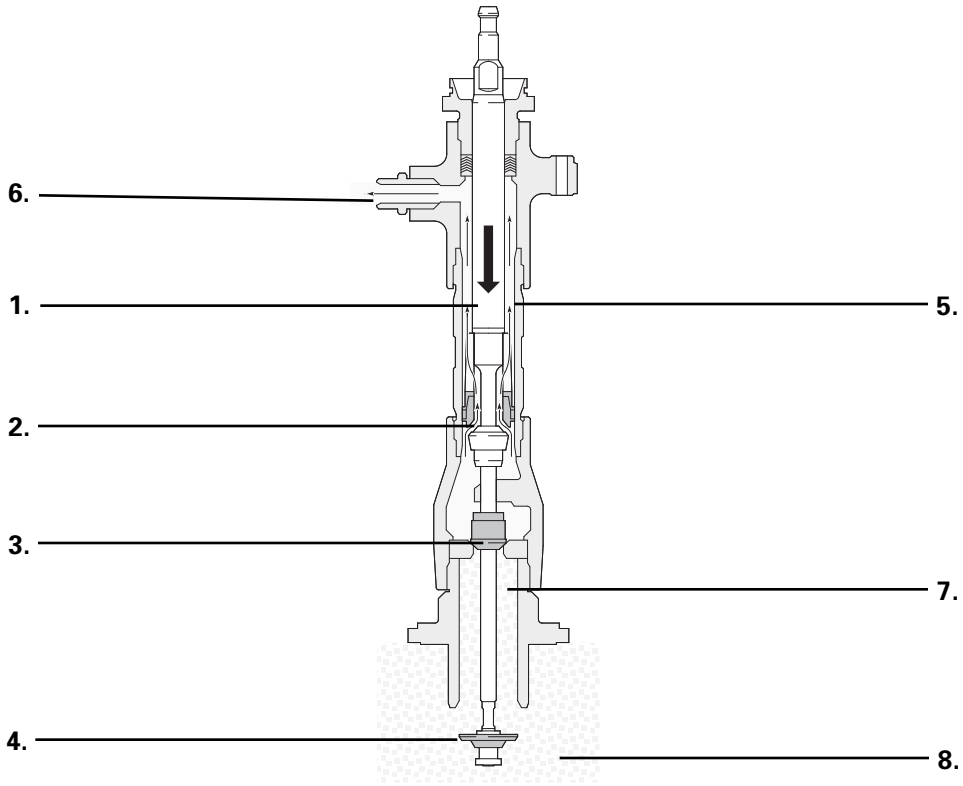
3. The intake check valve opens.
4. The priming piston is pulled up into the intake cylinder.
5. Any fluid above the piston check valve in the pump cylinder is trapped there. As the fluid displacement rod moves up, it forces half of the trapped fluid out of the pump through the fluid outlet. This occurs since the volume of the rod is half the volume of the pump cylinder.
6. A low-pressure area is created inside the pump cylinder below the piston assembly.
7. The priming piston and positive pressure push fluid from the supply container past the open intake check valve into the pump cylinder. Fluid fills 100 percent of the volume of the pump cylinder.

During top changeover, as the fluid displacement rod begins to move down, the priming piston pump



components work as shown in Figure 13:

Figure 13 Top changeover, priming piston pump.

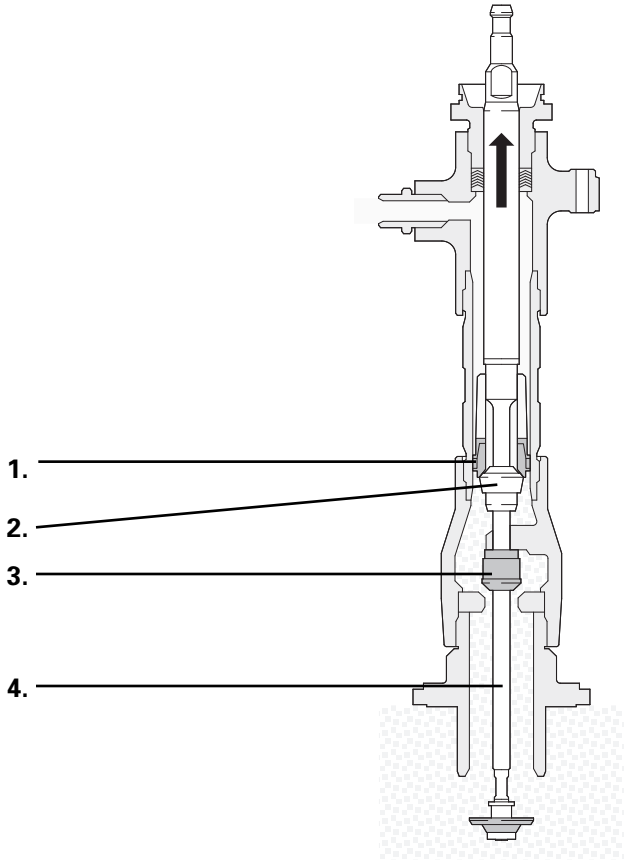
1. The piston bearing seal remains stationary due to frictional contact with the pump cylinder wall.
2. The piston check valve opens until the bottom of the fluid displacement rod contacts the top of the piston guide. Then the piston assembly moves down with the fluid displacement rod.
3. The intake check valve is in frictional contact with the priming piston rod. It moves down with the rod until it seats. Then the priming piston rod slides through the intake check valve and continues downward.

During downstroke, priming piston pump components work as shown in Figure 14:

Figure 14 Downstroke, priming piston pump.

1. The motor pushes the fluid displacement rod down.

2. The piston check valve opens.
3. The intake check valve closes.



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4. The priming piston is pushed out of the intake cylinder.
5. The fluid that was loaded into the pump cylinder during the upstroke is trapped inside the pump cylinder. It flows through the piston check valve.
6. Because the fluid displacement rod is half the volume of the pump cylinder, half the fluid transferred through the piston check valve in the pump cylinder is forced out of the pump through the fluid outlet. The other half of the fluid transferred through the piston check valve will be displaced out of the pump during the next upstroke.
7. A low-pressure area is created inside the intake cylinder.
8. Positive pressure pushes fluid from the supply container into the intake cylinder.

During bottom changeover, as the fluid displacement rod begins to move up, the priming piston

pump's components act work as shown in Figure 15:

Figure 15 Bottom changeover, priming piston pump.

1. The piston bearing seal remains stationary due to frictional contact with the pump cylinder wall.
2. The piston seat moves up and closes against the piston check. Then the piston assembly is pulled up with the fluid displacement rod.
3. The intake check valve is in frictional contact with the priming piston rod. It moves up with the rod and the intake check opens. The upward movement of the intake check is stopped by the priming piston rod guide located inside the intake housing.
4. The priming piston rod slides through the intake check valve and continues upward.

Progress Check

Directions: After answering the following questions, compare your answers with those proved in the answer key following this progress check. If you respond to any items incorrectly, return to the text and review the appropriate topics.

1. Can you identify four drive sources for two-check and priming piston pumps? *(Write your answers in 1–4 below.)*

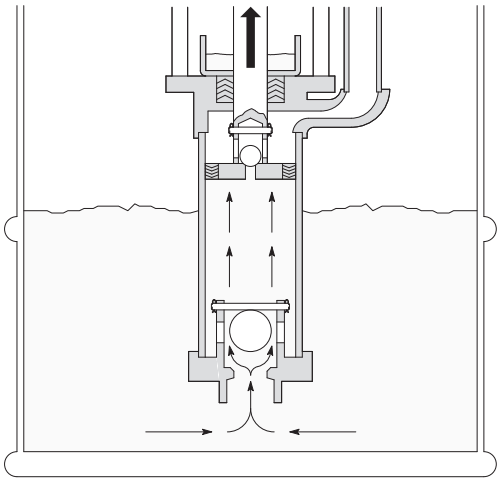


Figure 10 Upstroke, two-check piston pump.

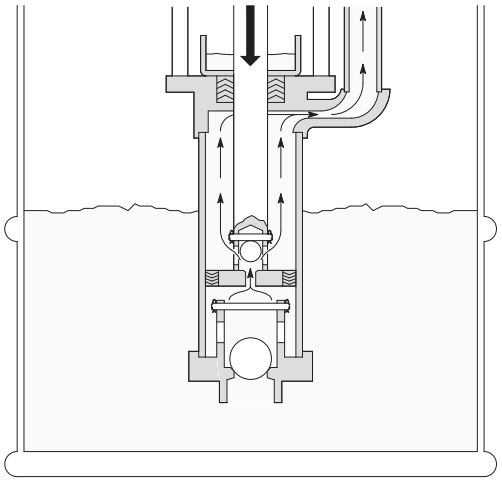


Figure 11 Downstroke, two-check piston pump.

[1] _____ a. _____

[2] _____ b. _____

[3] _____ c. _____

[4] _____ d. _____

2. For each drive source listed in the previous question, identify the component(s) that transfer motion to the fluid displacement rod in the pump. *(Write your answers in a–d above.)*

   Fill in the blanks to answer the following questions about the upstroke and downstroke phases of the two-check piston pump's operating cycle. Refer to the graphics for help.

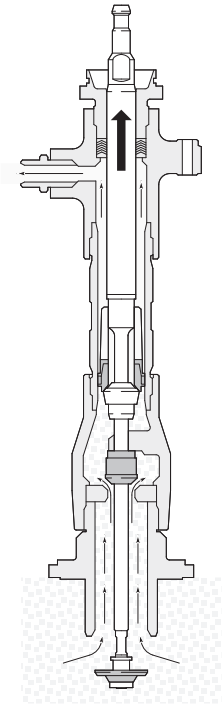
3. During upstroke:

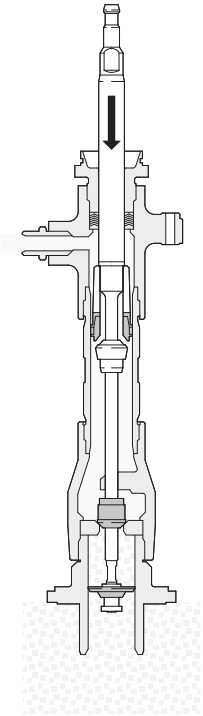
   a. The motor pulls the _____ up.

   b. The piston check valve _____.

c. The intake check valve _____.

d. _____ percent of the fluid above the piston check valve is displaced from the pump.





e. _____ percent of the volume of the pump cylinder fills with fluid from the supply container.

4. During downstroke:

   a. The motor pushes the _____ down.

   b. The piston check valve _____.

   c. The intake check valve _____.

   d. _____ percent of the fluid above the piston check valve is displaced from the pump.

   e. _____ percent of the volume of the pump cylinder fills with fluid from the supply container.

Now fill in the blanks to answer the following questions about the upstroke, downstroke, and changeover phases of the two-check piston pump's operating cycle. Again, refer to the graphics for help.

Figure 12 Upstroke, priming piston pump.

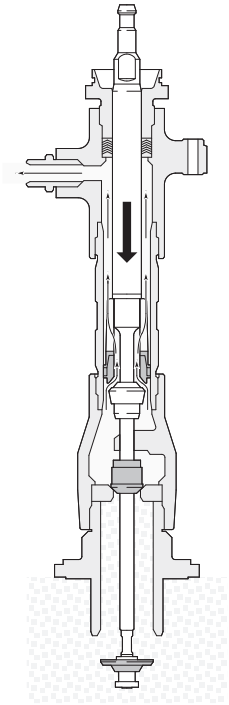
Figure 13 Top changeover, priming piston pump.

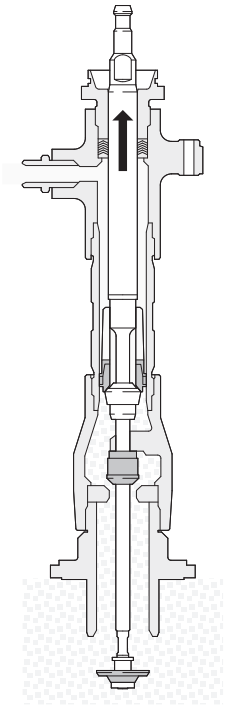
5. During upstroke:

   a. The motor pulls the _____ up.

   b. The piston check valve _____.

   c. The intake check valve _____.





d. The _____ is pulled up into the intake cylinder.

e. _____ percent of the fluid above the piston check valve is displaced from the pump.

f. _____ percent of the volume of the pump cylinder fills with fluid from the supply container.

6. During top changeover:

   a. The _____ remains stationary.

   b. The piston check valve _____ until the fluid displacement rod contacts the _____. Then the piston assembly moves _____ with the fluid displacement rod.

   c. The intake check valve moves _____ with the priming piston rod until it _____. Then the _____ slides through the intake check valve and continues _____.

Figure 14 Downstroke, priming piston pump. **Figure 15** Bottom changeover, priming piston pump.

7. During downstroke:

   a. The motor pushes the _____ down.

   b. The piston check valve _____.

   c. The intake check valve _____.

   d. The _____ is pushed down and out of the intake cylinder.

e. _____ percent of the fluid above the piston check valve is displaced from the pump.

f. _____ percent of the volume of the pump cylinder fills with fluid from the supply container.

8. During bottom changeover:

   a. The _____ remains stationary.

   b. The piston check valve _____. Then the piston assembly moves _____ with the fluid displacement rod.

   c. The intake check valve _____, moving _____ with the priming piston rod until it meets the _____. Then the _____ slides through the intake check valve and continues _____.

Answers to Progress Check

1. Two-check and priming piston pumps can be driven by:

   Any order is correct.

   [1] Air motors

   [2] Hydraulic motors

   [3] Electric motors

   [4] Gas engines

2. The component(s) in each drive source that transfer motion to the pump are the:

   [1] Air motors — a. Motor rod

   [2] Hydraulic motors — b. Motor rod

[3] Electric motors

[4] Gas engines

c. Gears and cam

d. Clutch and gears

3. The correct answers are:

   During the two-check piston pump's upstroke:

   a. The motor pulls the fluid displacement rod up.

   b. The piston check valve closes.

   c. The intake check valve opens.

   d. 50 percent of the fluid above the piston check valve is displaced from the pump.

   e. 100 percent of the volume of the pump cylinder fills with fluid from the supply container.

4. The correct answers are:

   During the two-check piston pump's downstroke:

   a. The motor pushes the fluid displacement rod down.

   b. The piston check valve opens.

   c. The intake check valve closes.

   d. 50 percent of the fluid above the piston check valve is displaced from the pump.

   e. 0 percent of the volume of the pump cylinder fills with fluid from the supply container.

5. The correct answers are:

   During the priming piston pump's upstroke:

   a. The motor pulls the fluid displacement rod up.

   b. The piston check valve closes.

   c. The intake check valve opens.

d. The priming piston is pulled up into the intake cylinder.

e. 50 percent of the fluid above the piston check valve is displaced from the pump.

f. 100 percent of the volume of the pump cylinder fills with fluid from the supply container.

6. The correct answers are:

   During the priming piston pump's top changeover:

   a. The piston bearing seal remains stationary.

   b. The piston check valve opens until the fluid displacement rod contacts the piston guide. Then the piston assembly moves down with the fluid displacement rod.

   c. The intake check valve moves down with the priming piston rod until it closes. Then the priming piston rod slides through the intake check valve and continues downward.

7. The correct answers are:

   During the priming piston pump's downstroke:

   a. The motor pushes the fluid displacement rod down.

   b. The piston check valve opens.

   c. The intake check valve closes.

d. The priming piston is pushed down and out of the intake cylinder.

e. 50 percent of the fluid above the piston check valve is displaced from the pump.

f. 0 percent of the volume of the pump cylinder fills with fluid from the supply container.

8. The correct answers are:

During the priming piston pump's bottom changeover:

a. The piston bearing seal remains stationary.

b. The piston check valve closes. Then the piston assembly moves up with the fluid displacement rod.

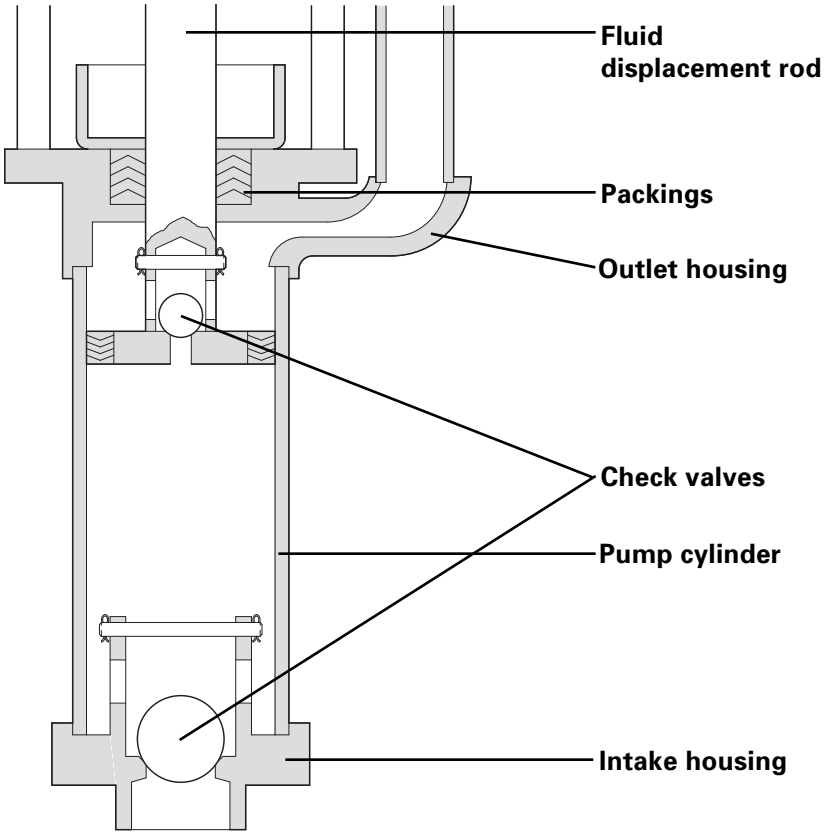
c. The intake check valve opens, moving up with the priming piston rod until it meets the priming piston rod guide. Then the priming piston rod slides through the intake check valve and continues upward.

Two-Check & Priming Piston Pumps: Materials of Construction

Learning Objectives

Part of your job is to help customers select two-check and priming piston pumps that are constructed of materials that are compatible with the fluids they will pump. This section discusses why this compatibility is important. It also explains how to identify compatible construction materials for two main types of wetted parts. Upon completion of the section, you should be able to:

- Understand the importance of selecting pumps that are made from materials that are compatible with the fluids to be pumped.

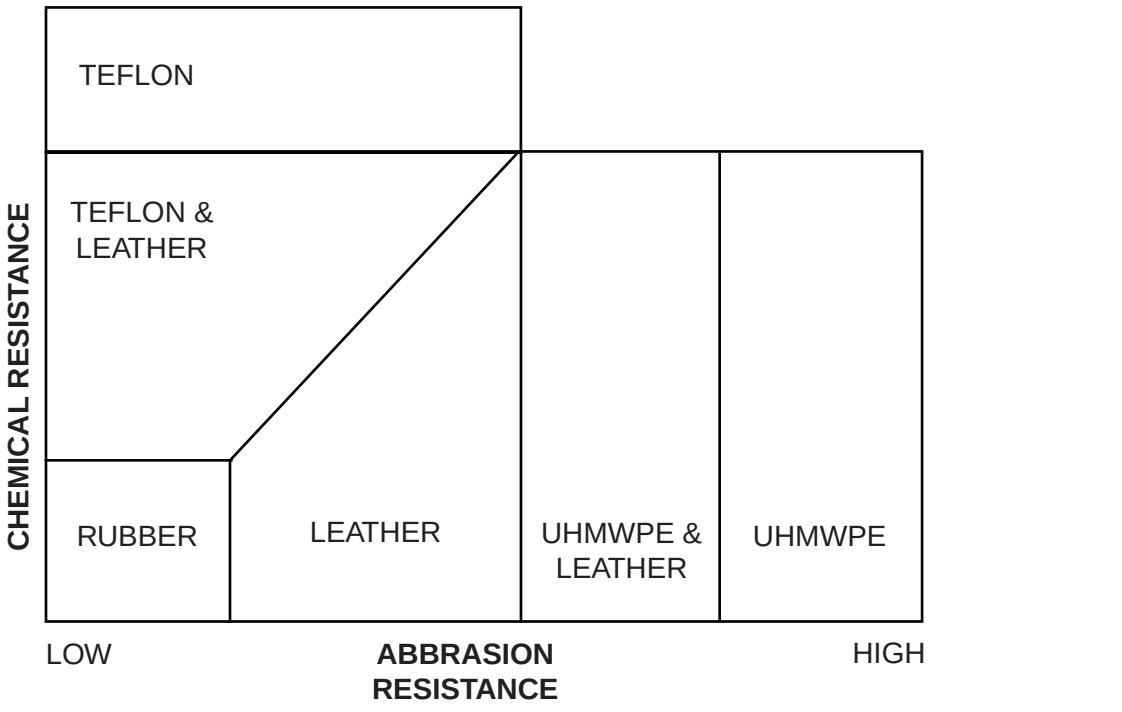


- Identify the main construction materials that Graco uses for pump seals and packings to reduce or eliminate abrasion and other damaging chemical reactions during pumping.
- Identify the main construction materials that Graco uses for pump metal wear parts to reduce or eliminate abrasion and corrosion during pumping.

Factors to Consider

Proper selection of a pump's wetted parts maximizes pump life, while improper selection can increase the frequency for necessary maintenance and repair. A pump's wetted parts (shown in Figure 16) are any that come in contact with the fluid being pumped. Most often, these are the seals and packings and the metal wear parts, which include the fluid displacement rod and the pump cylinder. Other wetted parts are ball checks and guides and intake and outlet housings.

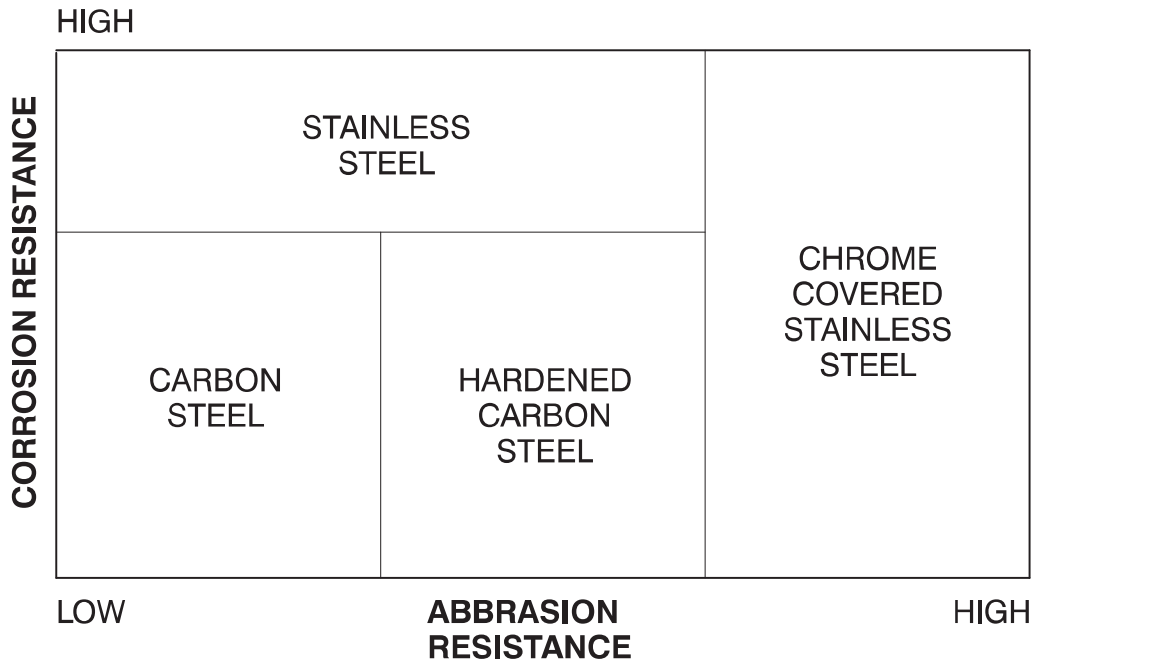
Figure 16 Wetted parts of a pump.



Fluid characteristics that need to be considered in selecting the construction materials for a pump's

wetted parts are:

- Abrasiveness.
- Corrosiveness.
- Other damaging chemical reactions.



The main types of construction materials that Graco uses for pump seals and packings include

rubber, leather, teflon & leather, teflon, ultra-high molecular weight polyethylene (UHMWPE), and UHMWPE & leather. The graph in Figure 17 shows you in general which of these construction materials are resistant to different levels of abrasion and other damaging chemical reactions that a pumped fluid may cause. For more detailed information on chemical compatibility, refer to the appropriate *Chemical Compatibility Chart* in the ***Graco Industrial Products Catalog.*** The maximum service temperature for seals and packings construction materials also needs to be considered.

Figure 17 Chemical Resistance Graph for Seals & Packings Construction Materials.

Construction materials that Graco uses for metal parts include carbon steel, stainless steel, hardened carbon steel, and chrome-covered stainless steel (severe duty). The graph in Figure 18 shows you in general which of these construction materials are resistant to different levels of abrasion and corrosion that a pumped fluid may cause. Again, for more detailed information on chemical compatibility, refer to the appropriate *Chemical Compatibility Chart* in the ***Graco Industrial Products Catalog.***

Figure 18 Chemical Resistance Graph for Metal Parts Construction Materials.

Progress Check

Directions: After answering the following questions, compare your answers with those proved in the answer key following this progress check. If you respond to any items incorrectly, return to the text and review the appropriate topics.

1. Why is it important that a pump's wetted parts are constructed of material best suited to handle the fluids being pumped?

   _____

   _____

   _____

2. What construction material(s) would likely be used for a pump's seals and packings to handle the fluids to be pumped in each of the following situations?

   Refer to Figure 17 to obtain your answers.

a. _____The fluid is highly abrasive but does not cause other damaging chemical reactions

b. _____ The fluid is not abrasive at all but causes a high level of other damaging chemical reactions

c. _____ The fluid is moderately abrasive and also causes a moderate level of other damaging chemical reactions

3. What construction material(s) would likely be used for a pump"s metal parts to handle the fluids to be pumped in each of the following situations?

Refer to Figure 18 to obtain your answers.

a. _____The fluid is highly abrasive but not at all corrosive

b. _____The fluid is highly corrosive but not at all abrasive

c. _____The fluid is moderately abrasive and also moderately corrosive

Answers to Progress Check

1. Proper selection of a pump's wetted parts maximizes pump life, while improper selection can increase the frequency for necessary maintenance and repair.

2. The correct answers are:

   a. UHMWPE The fluid is highly abrasive but does not cause other damaging chemical reactions

   b. Teflon The fluid is not abrasive at all but causes a high level of other damaging chemical reactions

   c. Leather or UHMWPE & leather The fluid is moderately abrasive and also causes a moderate level of other damaging chemical reactions

3. The correct answers are:

   a. Chrome-covered stainless steel The fluid is highly abrasive but not at all corrosive

   b. Stainless steel The fluid is highly corrosive but not at all abrasive

   c. Hardened carbon steel The fluid is moderately abrasive and also moderately corrosive

Two-Check & Priming Piston Pumps: Advantages & Limitations

Advantages	Limitations
They are versatile:	They cannot handle highly viscous, non-flowable, fiber- or chunk-filled materials, or greases
Can operate at higher pressures than other pumping technologies	
Can be used to pump abrasive and corrosive materials	They have a lower flow-rate limit than other pumping technologies.
Are relatively low-shear compared to other pumping technologies	
Do not require complex pump feed methods	Pulsation caused by changeover may require use of surge tanks, fluid regulators, or other fluid control devices.
Can stall under pressure	
Work well in explosive environments when driven by air motors	
They are reliable:	
Require little maintenance	
Are relatively easy to repair	

Learning Objectives

A thorough understanding of the advantages and limitations of two-check and priming piston pumps can help you to effectively position these products with customers. This section discusses these advantages and limitations and explains what they mean to customers. Upon completion of the section, you should be able to:

- Describe advantages and limitations of two-check piston pumps.
- Describe advantages and limitations of priming piston pumps.

Two-Check Piston Pumps: Advantages and Limitations

As stated previously, two-check piston pumps comprise a large percentage of Graco's product line. Figure 19 shows the main advantages and limitations of this pump design.

Two-Check Piston Pumps

Figure 19 Advantages and limitations of two-check piston pumps.

As you can see, the main advantages are:

Versatility

Two-check piston pumps can be used to pump flowable liquids in a wide variety of market applications. They can operate at higher pressures than other pumping technologies. That means they can be used for more things, such as spray applications or long-distance pumping. Two-check piston pumps can be used to economically pump abrasive and corrosive materials compared to other pumping technologies. Also, they are relatively low-shear compared to other pumping technologies, and so can handle paint and other materials without causing degradation. Two-check piston pumps do not need to be immersion or pressure fed. Siphon or gravity feed methods may be used. They have the ability to stall without damage under pressure, eliminating the need for recirculation. And, since most two-check piston pumps are powered by air motors, they work well in explosive environments,

for example, in pumping flammable solvents or solvent-based materials.

Reliability

Two-check piston pumps are low-maintenance pumps that are relatively easy to repair. They last a long time even when used to pump abrasive, corrosive fluids.

Limitations of a two-check piston pump design are:

- They cannot be used to pump high-viscosity, non-flowable, fibrous, filled, materials or greases
- They have a low flow rate limit compared to some other pumping technologies. If a high flow rate is needed, for example, for high-volume transfer applications, a diaphragm pump must be used.
- They may require the use of surge tanks, fluid regulators, or other fluid control devices due to the pulsation caused by changeover.

The bottom line for customers is that two-check piston pumps represent a reliable, cost-effective means of pumping a wide variety of fluids.

Priming Piston Pumps: Advantages and Limitations

Figure 20 shows the main advantages and limitations of a priming piston pump design, some of which are similar to those of the standard two-check piston pump:

Advantages	Limitations
They are versatile:	They are more expensive to manufacture than standard piston pumps because they have more components.
Can handle highly viscous, non-flowable, fiber- or chunk-filled materials and greases better than any other kind of pumping technology	They require more complex pump feed methods (immersion or pressure feed) for loading viscous materials.
Can operate at higher pressures than other pumping technologies	
Can be used to pump abrasive and corrosive materials. Are relatively low-shear compared to other pumping technologies	
They are reliable:	
Require little maintenance	
Are relatively easy to repair	

Versatility

Priming piston pumps can handle high-viscosity, non-flowable, fiber- or chunk-filled materials and greases better than any other kind of pumping technology. They can also handle some thinner fluids. Like standard two-check piston pumps, priming piston pumps can operate at higher pressures than other pumping technologies, so they can be used for more things, such as pumping semi-solid materials. And, like standard two-check piston pumps, priming piston pumps can be used to economically pump abrasive and corrosive materials. New designs are relatively low-shear compared to other pumping technologies. They can handle fluids and semi-solid materials without causing degradation.

Reliability

Like standard two-check piston pumps, priming piston pumps are low-maintenance pumps that are relatively easy to repair. They last a long time even when used to pump abrasive, corrosive fluids.

Priming Piston Pumps

Figure 20 Advantages and limitations of priming piston pumps.

The limitations of a priming piston pump design are that:

They are more expensive to manufacture than standard two-check piston pumps because they have

They involve the use of more complex pump feed methods, such as follower plates or inductor or ram systems, to load viscous materials into the pump.	
For customers, priming piston pumps represent the only means available to pump high-viscosity, non-flowable, fiber- or chunk-filled materials and greases. They are reliable, long-lasting, and require little maintenance.	
Progress Check ***Directions: After answering the following questions, compare your answers with those proved in the answer key following this progress check. If you respond to any items incorrectly, return to the text and review the appropriate topics.***	

1. The main advantages of two-check and priming piston pumps are that they are versatile and reliable. Can you list two examples of this versatility and reliability for each type of pump? *(Fill in the blanks in the chart below.)*

Versatility:	Versatility:
_____	_____
_____	_____
_____	_____
Reliability:	Reliability:
_____	_____
_____	_____
_____	_____

2. Which are limitations of a two-check piston pump design?

   You may select one or more answers.

   a. They are comparatively high-shear.

b. They require complex pump feeding methods.

c. They have a relatively low flow-rate limit.

d. They are relatively expensive to manufacture.

Versatility: Can operate at higher pressures than other pumping technologies Can be used to pump abrasive and corrosive materials Are relatively low-shear compared to other pumping technologies Do not require complex pump feed methods Are safe in explosive environments when powered by air motors	Are relatively easy to repair **Versatility:** Can handle highly viscous, non-flowable, fiber- or chunk-filled materials and greases better than any other kind of pumping technology Can operate at higher pressures than other pumping technologies Can be used to pump abrasive and corrosive materials Are relatively low-shear compared to other pumping technologies
Reliability: Require little maintenance	**Reliability:**

f. They require frequent maintenance.

3. Which are limitations of a priming piston pump design?

You may select one or more answers.

a. They are comparatively high-shear.

b. They require complex pump feeding methods.

c. They have a relatively low flow-rate limit.

d. They are relatively expensive to manufacture.

e. They cannot handle highly viscous materials.

f. They require frequent maintenance.

Answers to Progress Check

1. Any two of the answers in each set are correct:

2. C and e are correct. The limitations of a two-check piston pump design are:
   - They cannot be used to pump high-viscosity, non-flowable, fibrous, filled, materials or greases.
   - They have a low flow rate limit compared to some other pumping technologies.

3. B and d are correct. The limitations of a priming piston pump design are:
   - They are more expensive to manufacture than standard two-check piston pumps because they have more components.
   - They involve the use of more complex pump feed methods, such as follower plates or inductor or ram systems, to assist in pump priming.

Two-Check & Priming Piston Pumps: Uses

Learning Objectives

Understanding how two-check and priming piston pumps are typically used can give you a useful market perspective. This section identifies the main types of fluids that Graco two-check and priming piston pumps are used for and discusses the main markets for and tasks performed by these two types of pumps. Upon completion of the section, you should be able to:

- Identify the types of fluids pumped, markets served, and tasks performed by Graco two-check piston pumps
- Identify the types of fluids pumped, markets served, and tasks performed by Graco priming piston pumps

Two-Check Piston Pumps: Uses

Graco standard two-check piston pumps are used primarily for

Paints and coatings

The largest part of the paints and coatings market is in the industrial area. Main market segments there include the wood finishing, metal paint finishing, and plastic finishing industries. A smaller part of the paints and coatings market is in the contractor equipment area for architectural (interior and exterior building) paint. The main tasks performed are transfer applications, spray applications,

metered and unmetered dispensing, and fluid circulation.

Lubricants, mainly oils

The major market segments in the lubricant market include service stations, auto dealerships, and mining operations. The main tasks performed are transfer applications and metered and unmetered dispensing.

Miscellaneous fluids

The main types of miscellaneous fluids pumped by two-check piston pumps are sealants and adhesives and food, pharmaceuticals, and cosmetics.

Major markets for sealants and adhesives are in the industrial and automotive areas. Industrial markets include building components, product assembly, appliance, and furniture manufacturing, while the main automotive market is the automobile manufacturing industry. The main tasks performed are general bonding and seam sealing and spray applications. The food, pharmaceuticals, and cosmetics market includes both sanitary and non-sanitary applications. The main tasks performed are bulk transfer applications, spray applications, and metered and unmetered dispensing.

Priming Piston Pumps: Uses

The main uses for Graco priming piston pumps are:

Non-flowable sealants and adhesives

Again, the major markets for sealants and adhesives are in the industrial and automotive areas. Industrial markets include building components, product assembly, appliance, and furniture manufacturing, and the main automotive market is the automobile manufacturing industry. The main tasks performed are general bonding and seam sealing.

Lubricants, mainly greases

Major market segments include service stations, auto dealerships, and mining operations. The main tasks performed are transfer applications and metered and unmetered dispensing.

Miscellaneous materials

The main types of miscellaneous materials pumped by priming piston pumps include food, pharmaceuticals, and cosmetics and other materials, such as plastisol, a component used in the manufacture of vinyl. The food, pharmaceuticals, and cosmetics market includes both sanitary (for example, peanut butter, tomato paste) and non-sanitary (for example, grease, dog food) applications. Main tasks performed are metered and unmetered dispensing and transfer applications.

Progress Check

Directions: After answering the following questions, compare your answers with those proved in the answer key following this progress check. If you respond to any items incorrectly, return to the text and review the appropriate topics.

1. What main types of fluids are two-check piston pumps used for?

   a. _____

   b. _____

   c. Miscellaneous fluids, mainly:

      [1.] _____

      [2.] _____

2. Fill in the blanks as directed below to answer the questions about the markets served and tasks performed by two-check piston pumps.

a. The largest part of one market shown in Question 1(a) or 1(b) above is in the industrial area for wood finishing, metal paint finishing, and plastic finishing industries. A smaller part of that same market is in the contractor equipment area for architectural use. What are the main tasks performed in this market by the two-check piston pumps?

List three tasks.

[1.] _____

[2.] _____

[3.] _____

b. The main tasks performed by two-check piston pumps in the other market shown in Question 1(a) or 1(b) above are transfer applications and metered and unmetered dispensing. What are major markets served?

List two markets.

[1.] _____

[2.] _____

3. What fluids are priming piston pumps used for?

a. _____

b. _____

c. Miscellaneous fluids, mainly: _____

4. Fill in the blanks as directed below to answer the questions about the markets served and tasks performed by priming piston pumps.

   a. Major segments of a market shown in Question 3(a) or 3(b) above are in the industrial and auto motive areas. Industrial markets include building components, product assembly, appliance, and furniture manufacturing, while the main automotive market is the automobile manufacturing industry. What are the main tasks performed by the priming piston pumps?

   List two tasks.

   [1.] _____

   [2.] _____

   b. The main tasks performed by priming piston pumps in the other market shown in Question 3(a) or 3(b) above are transfer applications and metered and unmetered dispensing. What are major markets served?

   List two markets.

   [1.] _____

   [2.] _____

Answers to Progress Check

1. Two-check piston pumps are used for:

   Any order is correct

a. Paints and coatings

b. Lubricants, mainly oils

c. Miscellaneous fluids, mainly:

   [1.] Sealants and adhesives

   [2.] Foods, pharmaceuticals, and cosmetics

2. The correct answers are:

a. The major part of the paints and coatings market is in the industrial area for wood finishing, metal paint finishing, and plastic finishing industries. A smaller part of the paints and coatings market is in the contractor equipment area for architectural use. The main tasks performed by the two-check piston pumps are:

Any three are correct.

[1.] Transfer applications

[2.] Spray applications

[3.] Metered and unmetered dispensing

[4.] Fluid circulation

b. The main tasks performed by two-check piston pumps in the lubricants market are transfer applications and metered and unmetered dispensing. The major markets served are:

Any two are correct.

[1.] Service stations

[2.] Auto dealerships

[3.] Mining operations

3. Priming piston pumps are used for:

a. Non-flowable sealants and adhesives

b. Lubricants, mainly greases

c. Miscellaneous fluids, mainly: Food, pharmaceuticals, and cosmetics

4. The correct answers are:

a. Major segments of the non-flowable sealants and adhesives market are in the industrial and auto motive areas. Industrial markets include building components, product assembly, appliance, and furniture manufacturing, while the main automotive market is the automobile manufacturing industry. The main tasks performed by the priming piston pumps are:

[1.] General bonding

[2.] Seam sealing

b. The main tasks performed by priming piston pumps in the lubricants market are transfer applications and metered and unmetered dispensing. The major market served are:

Any two are correct.

[1.] Service stations

[2.] Auto dealerships

Notes

Notes

Notes

Module Evaluation

The purpose of this Module Evaluation is to help the Graco Technical Communications department determine the usefulness and effectiveness of the module.

Instructions: Please complete the evaluation, tear it on the perforation, and return to: Graco Technical Communications Department, P.O. Box 1441, Minneapolis, MN 55440-1441, USA.

1. ***Based on the objectives, this module:***

   - ☐ Significantly exceeded my expectations
   - ☐ Exceeded my expectations
   - ☐ Met my expectations
   - ☐ Was below my expectations
   - ☐ Was significantly below my expectations

2. ***Why did you select the above rating?***

3. ***How do you plan to use the module information in your job?***

4. ***How do you think the module could be improved?***

I verify that I have successfully completed Module No. 321-044, Two-Check & Priming Piston Pumps

Signature _____

Date _____

Graco
Technical Communications Dept.
P.O. Box 1441
Minneapolis, MN 55440-1441 U.S.A.

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This module was developed by the Graco Technical Communications Department with assistance from the following individuals:

Kurt Thostenson
Brian Johnson
Todd Craft
Al Brus

The Graco Concept and Theory Training program consists of the following topics:

Fluid Basics
Atomization
Electrostatic Spray Finishing
Safety
Airspray Technology
Fluid Types: Paints and Other Coatings
Fluid Types: Lubricants
Fluid Types: Sealants and Adhesives
Airless Atomization
Spraying Techniques
Transfer Efficiency
Fluid Movement
Fluid Controls
Pumps
Motors and Power Sources
Plural Component Paint Handling
Plural Component Sealant and Adhesive Handling
Paint Circulating Systems
Automatic Finishing
Lube Reels and Dispense Valves
Lube Metering Systems
Electronic Fluid Management Systems

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